

Developing an Effective E-Textbook for CS101 Students at UH Hilo: An iBook Instructional Module

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Abstract: Today's college students rely on digital devices to socialize, organize, and search for information. Many are opting for digital learning resources in place of print textbooks; therefore, institutions of higher education need to address students' changing needs. Recent studies have found that the mere transfer of print books to digital format without interactive components does not affect performance or engagement of students (Larson, 2010; Weisberg, 2011). As CS101 instructors at the University of Hawaii at Hilo consider adapting traditional print resources to digital format, this research project aims to determine effective design and implementation strategies. An interactive e-textbook was developed using iBooks Author with a variety of widgets added to maximize interactivity, learning, motivation and engagement. College and pre-college students voluntarily participated by responding to a survey and a test before learning about HTML from a self-instructional e-textbook. After completing the e-textbook, participants responded to a post-survey and a post-test. Seventy-three percent of participants who completed the e-textbook scored better on the post-test than the pre-test. Most found the interactive widgets helpful and see e-textbooks as a viable alternative to print textbooks.

Introduction

Today's college students are digital natives who use digital devices to socialize, organize, and learn. Acceptance of e-textbooks by college students is on the rise (Reynolds, 2011) and in fact, the students are demanding resources that are not limited by time and space constraints (Nicholas & White, 2012). One way to meet the changing needs of this population may be to use electronic learning materials that are more native and effective.

The instructors of CS101, "Digital Tools for the Information World," at the University of Hawaii at Hilo (UH Hilo) are considering electronic textbooks (e-textbooks) as an alternative to print textbooks, but a study is needed to determine effective design and strategies before implementing e-textbooks. Many studies note that an e-textbook is more effective when content integrates multimedia, hyperlinks, and other interactive tools (Chong, Ling, & Lim, 2009; Lamb & Johnson, 2011; Larson, 2010; Nelson, 2008). Therefore, the purpose of this instructional design project is to develop a prototype interactive e-textbook for CS101 students at UH Hilo and evaluate its effectiveness in increasing learning, motivation, and engagement.

Background

For many years, the UH Hilo Computer Science department has been writing and printing textbooks for its popular non-majors' course, CS101. Approximately 100 students enroll in this course each semester to learn concepts and techniques of spreadsheets, databases, word processing, and webpages. The course includes a one-week module on basic Hyper-Text Mark-up Language (HTML) to create webpages, which is a new concept for most students. This target population is in their first or second year in college, are majoring in business or social science, are mostly residents of Hawaii, and are active users of technology but usually not familiar with HTML programming.

Nationwide, digital reading devices in the marketplace and among college students are continuing to grow (DeSantis, 2012). College students are also showing increasing preference for electronic books (Reynolds, 2011; Weisberg, 2011). At the same time, today's students are too "plugged-in" and "easily distracted with short attention spans" (Pew Internet, 2012). At UH Hilo, the current student population may have less access to costly hardware and software compared to their counterparts on Oahu or the mainland, but they still spend many hours interacting with electronic devices. CS101 instructors agree that, as a result, the current students seem to spend less time reading traditional textbooks or searching through printed pages to prepare for learning. Some students have asked about availability of electronic version of the assigned textbook (UHH CS Department, 2011).

Studies have shown that the mere transfer of print material to digital format without interactive features has no impact on learning (Larson, 2010; Weisberg, 2011). Chong, Lim and Ling (2009) determined that an effective e-book needs to have dynamic interactive visuals, good hardware design, and high usability. Good e-book hardware would include high resolution display, balance between portability and legibility, and robustness as a device. Usability was defined as simple page design, easy navigation, and quality content. Thus, an e-textbook for the CS101 HTML unit was developed as an instructional module that includes interactive visuals and runs on a quality e-reader device, while striving to include quality design and content. The e-textbook was tested by a sample target population to determine its effectiveness as an alternative learning resource. Results and recommendations from this study may assist the UH Hilo Computer Science Department in formulating effective strategies for implementing e-textbooks and other digital learning materials.

Methods

Overview

An e-textbook prototype (see Figure 1) was developed using Apple's iBooks Author and delivered to learners through the iBooks app for iPad. Participants were students who fit the profile of a typical CS101 student at UH Hilo. Participants downloaded and used a

specially designed interactive self-instructional e-textbook to learn about the Web and HTML.

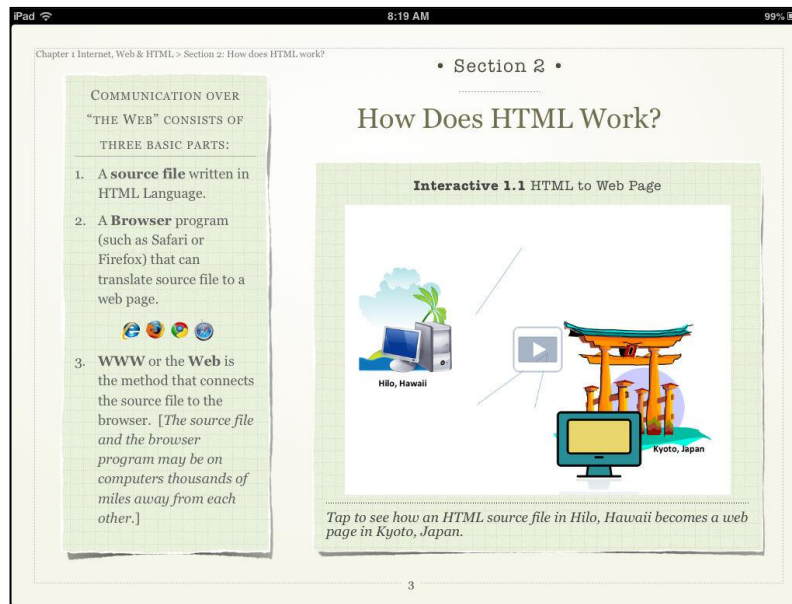


Figure 1. A sample page from the prototype e-textbook for HTML unit in CS101.

Device and Platform Considerations

The development platform needed to have affordable and capable e-authoring software, to create good design and interactive content (Chong et al., 2009; Larson, 2010). It also had to be coupled with a good quality e-reader device (Chong et al., 2009). Two file formats, ePub and iBook for iPad, were the most technologically-viable options for meeting both criteria.

The researcher chose Apple's iPad and iBooks Author after comparing options and cost. Currently, Apple's tablet hardware and its free iBooks Author program offer the best combination of ease of reading and ease of development. iBooks Author, which was first released in early 2012, has a drag-and-drop e-authoring user interface and a rich set of interactive widgets. The e-textbook for this project took advantage of iBooks Author's built-in, third-party, and custom widgets; chapter and section layouts; and an artistic "Craft" template. A direct URL link to the iBook file (in a Dropbox folder) was distributed to participants, thereby avoiding Apple's requirement of charging a price for the iBook if distributed through the iTunes Store.

The iPad is the current leader in the tablet market due to its design, high-resolution touch screen, and solid hardware (Whitney, 2013). It is well respected especially in academic reading (Kolowich, 2010) – but the significant drawback of selecting Apple products was the relatively low ownership of iPads among the target population in East Hawaii, which may have caused difficulty in finding study participants.

Project Website

The project entry point for participants was a website (<http://etext.weebly.com>) that guided them through the process. From the website, participants could submit the required consent form, take the pre-test and pre-survey, download the iBook, and respond to the post-test and post-survey. Surveys and tests were developed using Google Forms and embedded into the project website. The goal of the tests was to measure learning and engagement. Attitudinal surveys were administered before and after reading the e-textbook to determine learners' readiness and attitude toward e-textbooks, design preferences, effect on motivation and learning, and effectiveness of the whole and parts of the e-textbook.

Content Design and Development

Reading from a tablet-sized screen can pose special challenges for the reader. At the same time it presents an opportunity to utilize technology to break up information into chapters and sections, and smaller visually appealing textboxes, tables, images, multimedia, and other interactive widgets.

Following the Dick, Carey, and Carey (2009) instructional design model, sixteen learning objectives were identified for the HTML module, and a hierarchical chart was developed. Each learning objective then became the objective of each section, chapter, or the book during the development. This implementation of smaller-sized information units with clear objectives resulted in learner-appropriate information chunking. Using various interactive widgets (see Table 1) to present information resulted in multi-modal content delivery.

Table 1. Interactive widgets embedded in the e-textbook.

Where	Widget	Widget Type	Method/Creator
Introduction	Intro Video: How to use this e-book	Animated Keynote	iBooks Author widget
Chapter 1	"The Internet Explained"	YouTube Video	Video created by Wydea.com; iBook-Widgets (a 3 rd Party vendor) provided the widget shell
Section 1.1	"Information Pioneer: Sir Tim Berners-Lee"	Vimeo Video	Video created by BCS.org; iBook-Widgets provided the widget shell
Section 1.2	"HTML to Webpage"	Animated Keynote	iBooks Author widget
Section 1.3	"HTML to Webpage" #1, #2	PowerPoint Slideshows	iBooks Author widget
Section 1.3 Section 2.8 Section 3.2	Try-it-yourself Editor	Side-by-side source-to-output editor window	Open-source JavaScript code by K. Zhou (tryiteditor.com); Open-source iBook widget shell by T. Burnham (on github.com)

Section 1.4 Section 2.9 Section 3.3 Chapter 2	Review Questions with immediate feedback “The anatomy of a basic HTML file”	Quiz widget Labeled diagram	iBooks Author widget iBooks Author widget
Throughout	Images	Screenshots of Webpages that show the result of HTML source	
Throughout	Tables	Reference table of HTML tags, colors, and styles	

Participants

Emails to solicit for participation in the study were sent to two sections of the Spring 2013 CS101 classes and to other CS and Math classes at UH Hilo. A group of high school juniors and seniors at an all-girls private school on Oahu also participated, as they represented the population segment of future college students. One home-schooled high school junior from East Hawaii also participated by using a loaner iPad. A total of 17 participants took the pre-test, but 15 completed the post-test. Most were offered extra credit by their instructor, but participation was voluntary. iPad ownership was not required, as a loaner was available for anyone willing to participate.

Results

Attitudinal Survey Results

Surveys were administered through the project website and collected data on demographics, prior knowledge of HTML, experience with e-books, and attitude toward e-books and print books. Table 2 provides a summary of the participant profile. A surprisingly high percentage (81%) owned one or more e-reader devices and 71% had used an e-textbook before.

Table 2. Demographics.

<i>Demographics (n=17)</i>
65% of participants completed 0-1 year of college, and 29% completed 2-3 years
65% spend ≥4 hours each day on a digital device
69% owned an iPad; 38% owned a Kindle; only 19% did not own any e-reader device
88% had used some type of e-book before; and 71% had used an e-textbook before
Most often cited reasons for using e-textbook: portability (82%) and lower cost (36%)
53% were either a little familiar or not familiar at all with HTML before participation

Some survey questions asked participants about their attitude toward print books and e-books. Table 3 shows a slight but consistent increase in favorability toward e-textbooks after using the prototype e-textbook.

Table 3. Attitude toward electronic or print textbooks.

<i>Attitude toward electronic or print textbooks (n=15: participants who completed both pre-survey and post-survey)</i>	<i>Before</i>	<i>After</i>
What are your thoughts about e-textbooks?		
Alternative format to print textbooks	65%	86%
Will replace print textbooks	12%	36%
What are your thoughts about print textbooks?		
I love the smell of pages and flipping through them	47%	33%
Can't see how print books will go away	65%	60%
They may become rare	24%	33%
We need to save trees	24%	27%

Reinforcing the small increase in favorability were post-survey results where 67% said learning with an e-textbook was a “good experience”; 47% said it was “OK”; and 40% said it was “helpful.” When asked if they would recommend an e-book or e-textbook, 67% said they “might recommend an e-book to someone else”; and 13% would “definitely recommend an e-book.”

Commenting on the characteristics of e-textbooks, participants said e-textbooks are “more portable and accessible,” “will save paper,” “reinforces learning through interactivity,” and “more affordable.” Negative aspects cited were: “difficult to navigate,” “may run out of battery,” “difficult to read from the screen for a long period of time,” and “distracting for younger learners.”

Post-survey results showed that the majority of participants considered images, labeled diagrams, videos, and try-it-yourself widgets to be very helpful (see Figure 2). These were the **added interactive features** created by the author and embedded into the e-book. Interactive tools built into the e-reader program or the device – such as annotation tool, search box, and simulated page flipping – were rated slightly less helpful than the added interactive features. Several participants also commented that embedded quizzes were helpful, although it was inadvertently left out of the post-survey question on the e-textbook features.

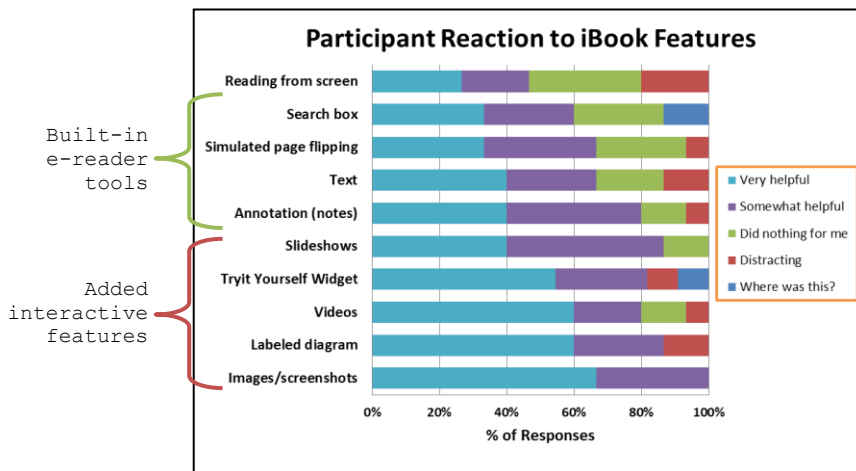


Figure 2. Rating of various features in the e-textbook (n=15).

Participant comments regarding the added interactive features included:

- “I like the interactive quizzes and try-it-yourself windows. It really helps in keeping the info in my brain.”
- “I really like how the images helped me and also got to try it right then and there.”
- “The review problems throughout were nice.”
- “The definitions that dropped down on one of the diagrams were helpful.”
- “I like the animations, videos, and graphics.”
- “The e-book...reinforces learning through interactivity.”

The only negative comment was “I should say this type of textbook would be very helpful to some, but distracting to others.” Mostly positive comments and the high helpfulness ratings (see Figure 2) confirmed that useful interactive features are helpful, as previous research has suggested (Larson, 2010).

Regarding the layout and design, most participants commented that they liked the overall format and design. However, a few mentioned that there was too much information in one section, “a confusing layout,” and “may be distracting to some readers.” Some recommended more images and examples as well as less information on a page.

Pre- and Post-test Results

Ninety-three percent of the participants said after using the e-textbook that “It all makes sense” or “I understood the basic concepts,” indicating that the e-textbook successfully delivered the content for learning. However, only 73% of participants who completed the e-textbook scored better on the post-test than they did on the pre-test (see Figure 3).

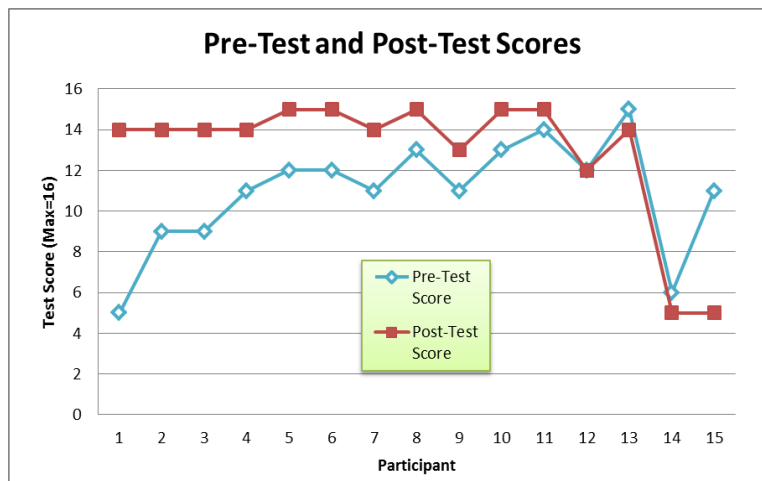


Figure 3. Test score comparison between pre-test and post-test.

In response to an open-ended question “share your thoughts about this research,” most participants said they liked the format of the book, images, and interactive widgets. Interesting insights included

- “I really think this is a great invention”
- “I like your idea and applaud it for college students”

- “I think in the future, people will find ways to make e-textbooks universal, and comfortable for people of all kind to use”
- “Using iBook is a very good approach to diversifying options for students... This will change the atmosphere of the classrooms: those with [print] textbooks, those with e-textbooks, and those using textbooks with the iBooks app.”

Discussion

Overall results showed that an e-textbook with useful interactive features and quality content delivered on a quality hardware device was well received and was generally helpful for learning. However, the study is inconclusive regarding motivation and engagement due to small sample size and the prototype e-textbook representing only one week of learning material in CS101.

An informal survey in the researcher’s current CS101 sections revealed that about 20% of students own an iPad. This explains the difficulty of finding UH Hilo students who own an iPad and were willing to spend time participating in the study. Although 69% of research participants owned an iPad and 12% more owned some other e-reader device, those figures probably do not reflect the general population of UH Hilo or CS101 students.

The iPad and iBooks Author were chosen for this study because they offered the best combination of e-reading/e-authoring products. For the target learners at UH Hilo, a more device-neutral format is recommended for actual e-textbook implementation.

To be more effective, an e-textbook should maximize interactivity while delivering solid content on a quality e-reader device. Use of multimedia, images, screenshots, and interactive review widgets, simple format, and aesthetic design are recommended. Existing review quizzes and instructional videos for CS101 in Laulima, the UH Hilo’s course management system, may be good features to incorporate into an e-textbook. Additionally, multiple learning options such as text transcript for videos or print option should be available to accommodate disabled learners and some learners who may have difficulty staring at a screen for an extended period.

Although an interactive e-textbook is recommended, further studies are needed. The researcher recommends conducting an action research study with a more representative target population, sufficient sample size, a longer time span of data collection with opportunities to measure time on task (engagement), and a baseline for comparison of test scores and attitudinal surveys with and without electronic textbooks.

Another discussion that needs to continue beyond this research is how digital learning materials should be developed for use at UH Hilo. Designing and developing a one-week module for this project took many hours of work. Implementing a rich interactive digital textbook for the entire semester would place an unreasonable burden on instructors. The researcher recommends that the University either hire a dedicated instructional designer or locate published material that would closely meet learning objectives. An investment

in analysis, design, development, implementation, and ongoing evaluation will help meet the needs of changing learners.

Conclusion

An e-textbook thoughtfully designed for the digital native college students has the potential of increasing learning, motivation, and engagement. This research recommends the following for developing an effective e-textbook for CS101:

- It should be platform-independent and work on many devices.
- It should be interactive.
- It should be multi-modal to accommodate disabled learners and learners who prefer print version.
- Conduct action research study to compare data with control groups using non-digital resources and non-interactive PDF resources.
- Invest in time and good design – hire an instructional designer or provide course release to an instructor to develop an e-textbook.
- Continue the needs analysis of the learners.
- Continue to evaluate what works and update learning materials.

Since this research project began, two new developments have added more urgency for identifying effective electronic learning materials. First, the Computer Science Department has given a cautious blessing on offering online sections of CS101. It is not practical for instructors to mail print textbooks to each student; therefore, online students will need to access an electronic form of the textbook.

Second, Hawaii State Governor Neil Abercrombie and the Hawaii Department of Education plan to “put a tablet or laptop in the hands of every student at every grade level (K-12)” and implement all curriculum materials on digital devices within the next three years (Stewart, 2013). If this Digital Materials Initiative in K-12 is implemented, in just a few years college students in Hawaii will demand that they continue learning with e-textbooks beyond their K-12 education.

Additionally, not just limited to Hawaii but nationwide, the sales of iPads to K-12 market has overtaken the sales of PC to schools (Needle, 2012). These factors have implications on future learning resources that higher educational institutions must consider and plan for. It is not a matter of if, but when and how colleges should implement e-textbooks. Incoming college students, like the high school students who participated in this study, will likely be more comfortable learning with an iPad or similar tablet device in place of print books. This study recommends that UH Hilo and other institutions of higher education focus on how best to provide appropriate learning resources for forthcoming e-book natives.

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